Managing drinking water treatment to avoid DBP formation

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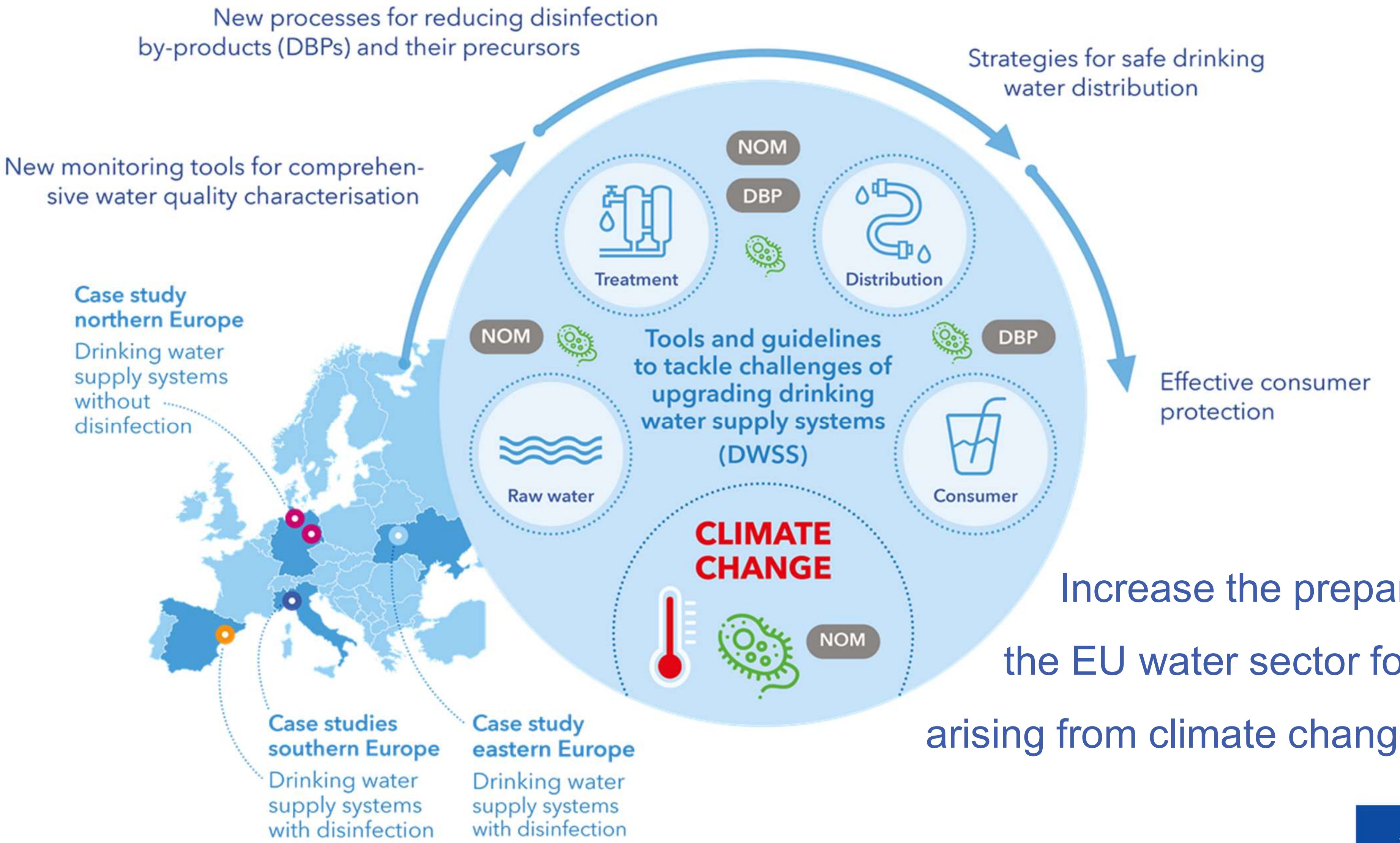
SafeCREW goal



Increase the preparedness of the EU water sector for challenges arising from climate change

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Project partners

- DVGW Research Centre TUHH
- Tutech GmbH
- Kompetenzzentrum Wasser Berlin
- Umweltbundesamt (Federal environment agency)
- Helmholtz Center for Environmental Research - UFZ

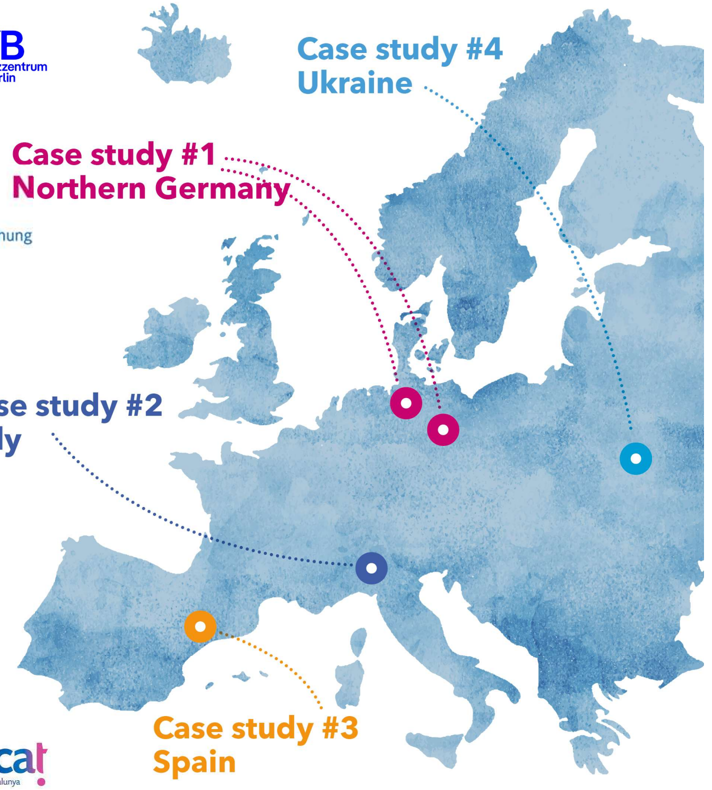
- Consorci d'Aigües de Tarragona
- EURECAT

- Metropolitana Milanese Spa
- Politecnico di Milano - POLIMI

- BioDetection Systems B.V.

- National University of Water and Environmental Engineering - NUWEE

- Multisensor Systems Limited



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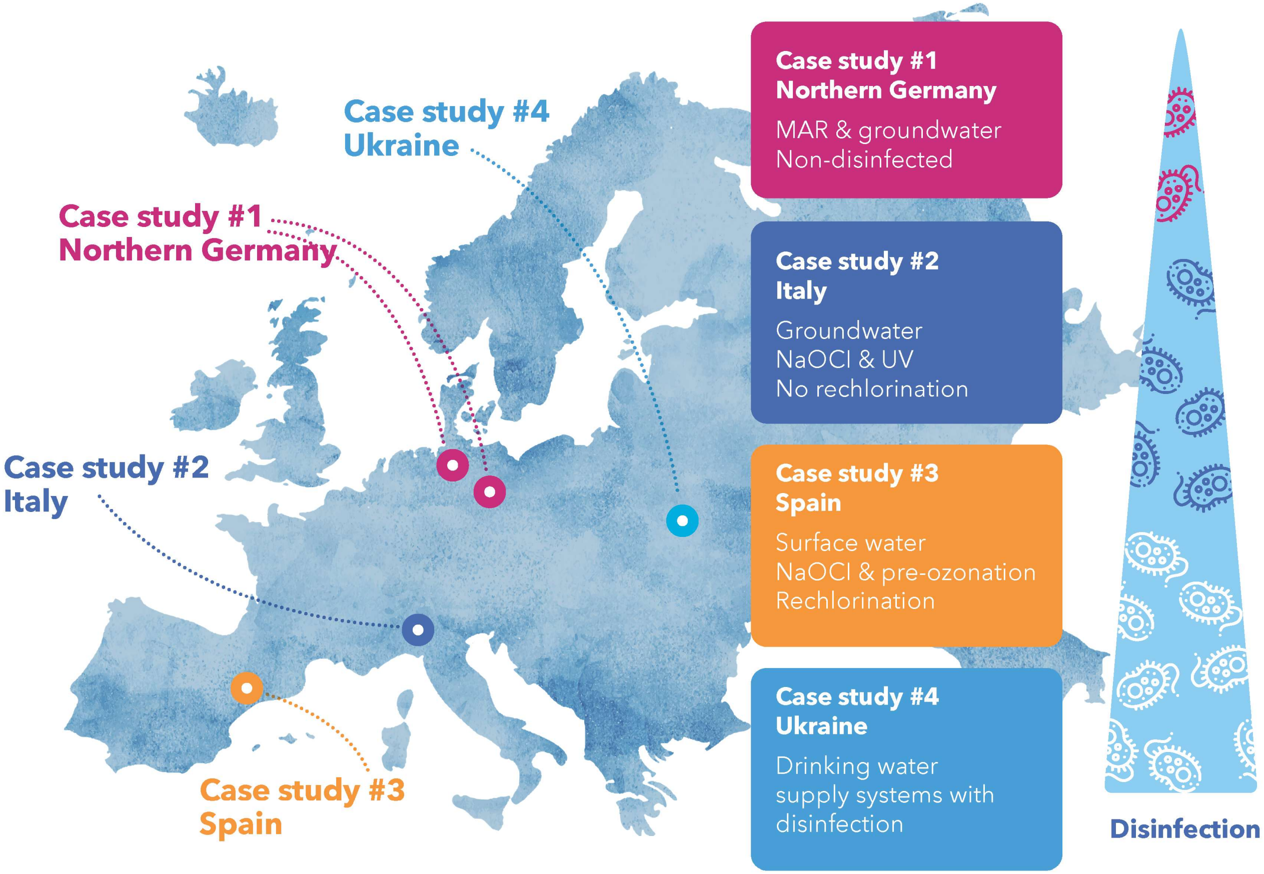
Case studies

Case Study #1: Berlin, Hamburg
- Ground water
- Innovative microbial monitoring for early warning
- Strategies for first time disinfection

Case Study #2: Milan
- Ground water
- Optimisation of disinfection
- Interaction of disinfectants with relining materials

Case Study #3: Tarragona
- **Surface water**
- **Reduction of DBP formation by changing NOM**
- **Prediction of DBPs in the network**
- **Integrated risk framework**

Case Study #4: Rivne
- Implementation of Water Safety Plans
- Soft sensors using low-informative data
- Identifying shortcommings in Ukrainian DW quality guidelines



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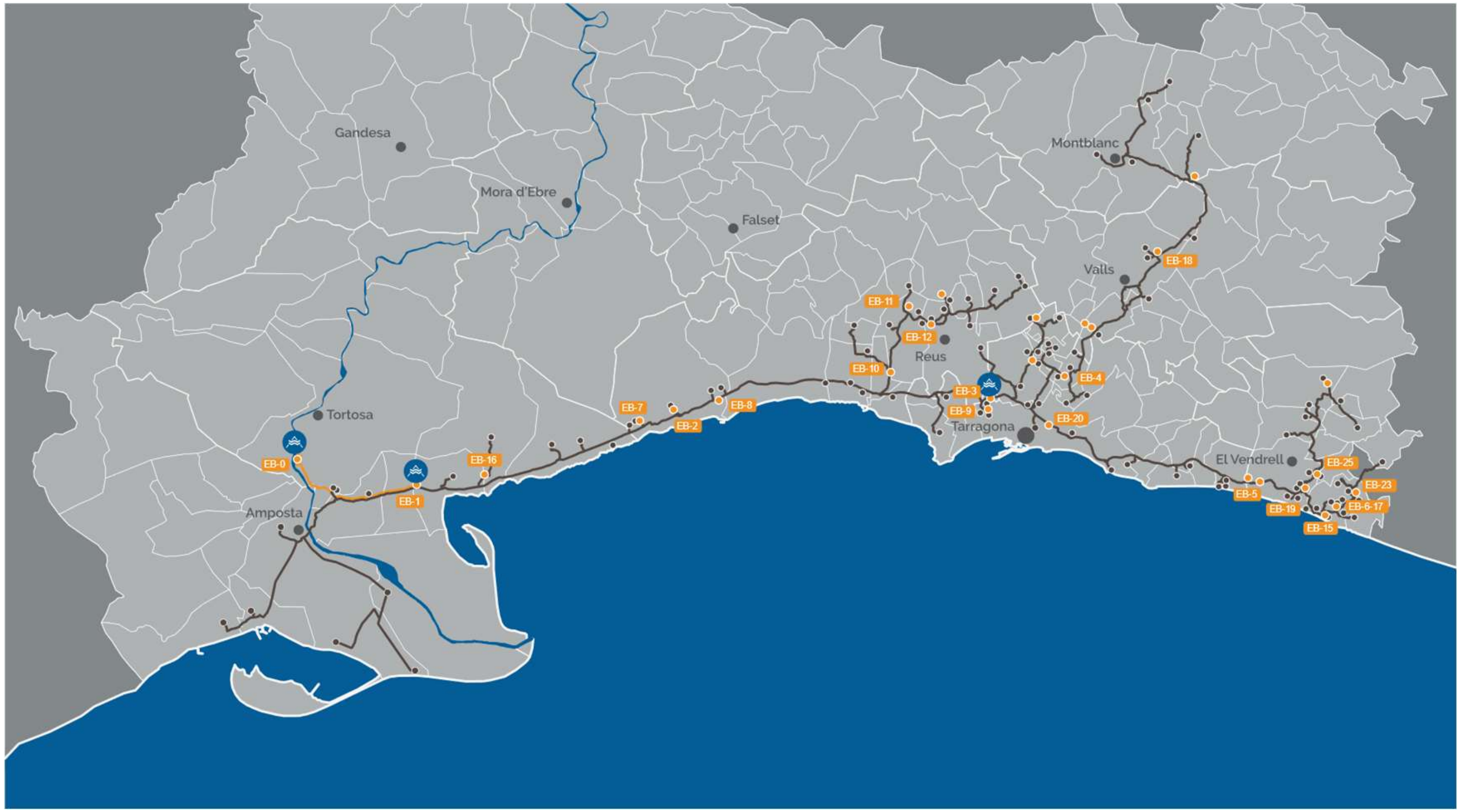
CS#3 Consorci d'Aigües de Tarragona

Consorci d'Aigües de Tarragona

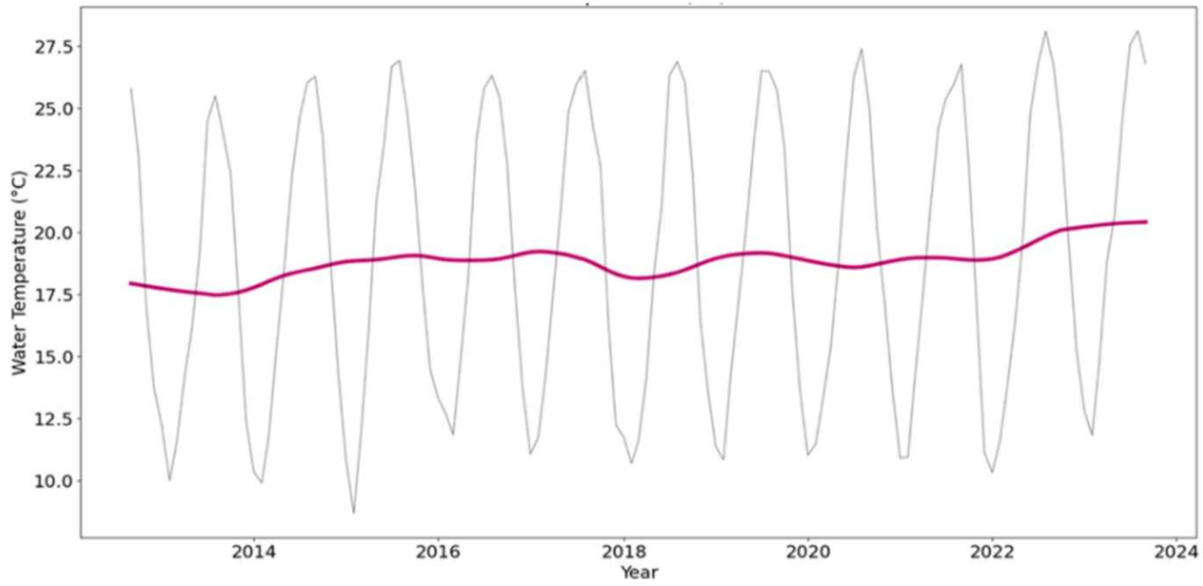


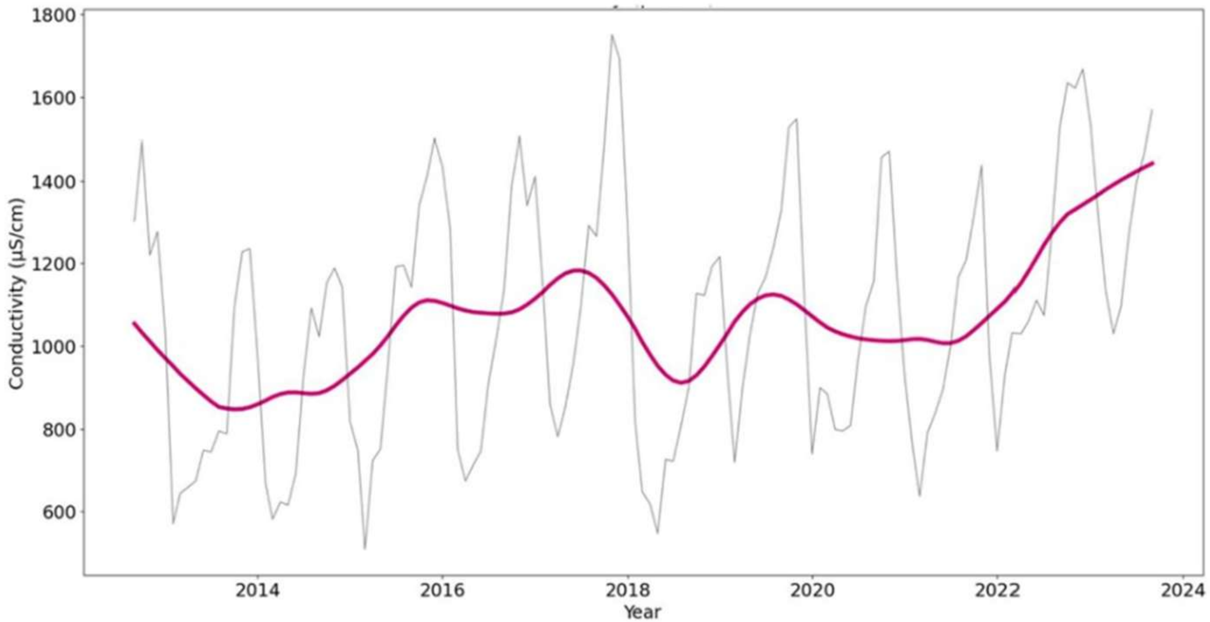
Since 1989, CAT can take up to 4.0 m^3/s of surface water from the Ebro river two irrigation channels.

Produces and distributes 75 hm^3 of safe drinking water to the 86% of the Tarragona Province (Spain) population (800k average / 1.5M max.)

69 municipalities and 27 industries
410 km of pipes and 400.000 m^3 of storage

CS#3 Climate change predictions on Ebro river





Water temperature increase of 2ºC in last 10 years

Conductivity rise due to low river flows

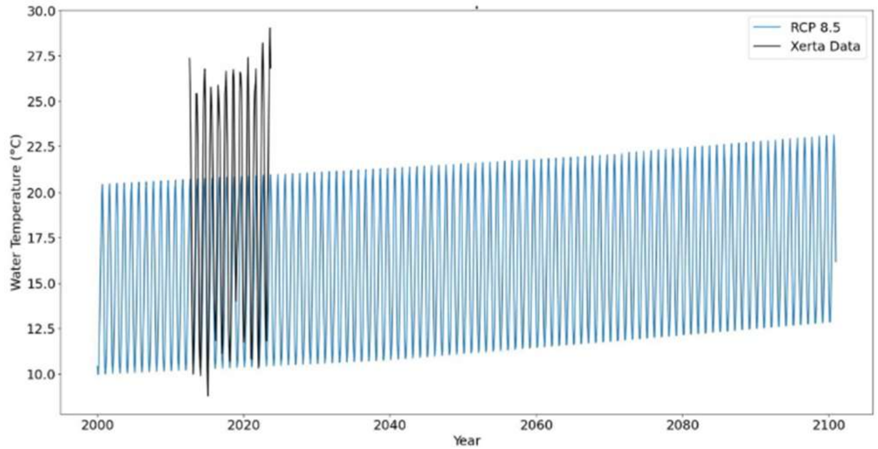


Figure 20. Water Temperature RCP8.5 projections compared to Xerta measurements.

All climate scenarios predict worsening conditions

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Climate Change

Surface Water Quality Changes

Severe Scenarios –
Uncontrolled water quality

Climate Change effects on CAT:

- Higher temperatures and conductivities on river water
- Algae blooms
- More treatment difficulties
- Less persistence of chlorine in the network
- More generation of DBPs

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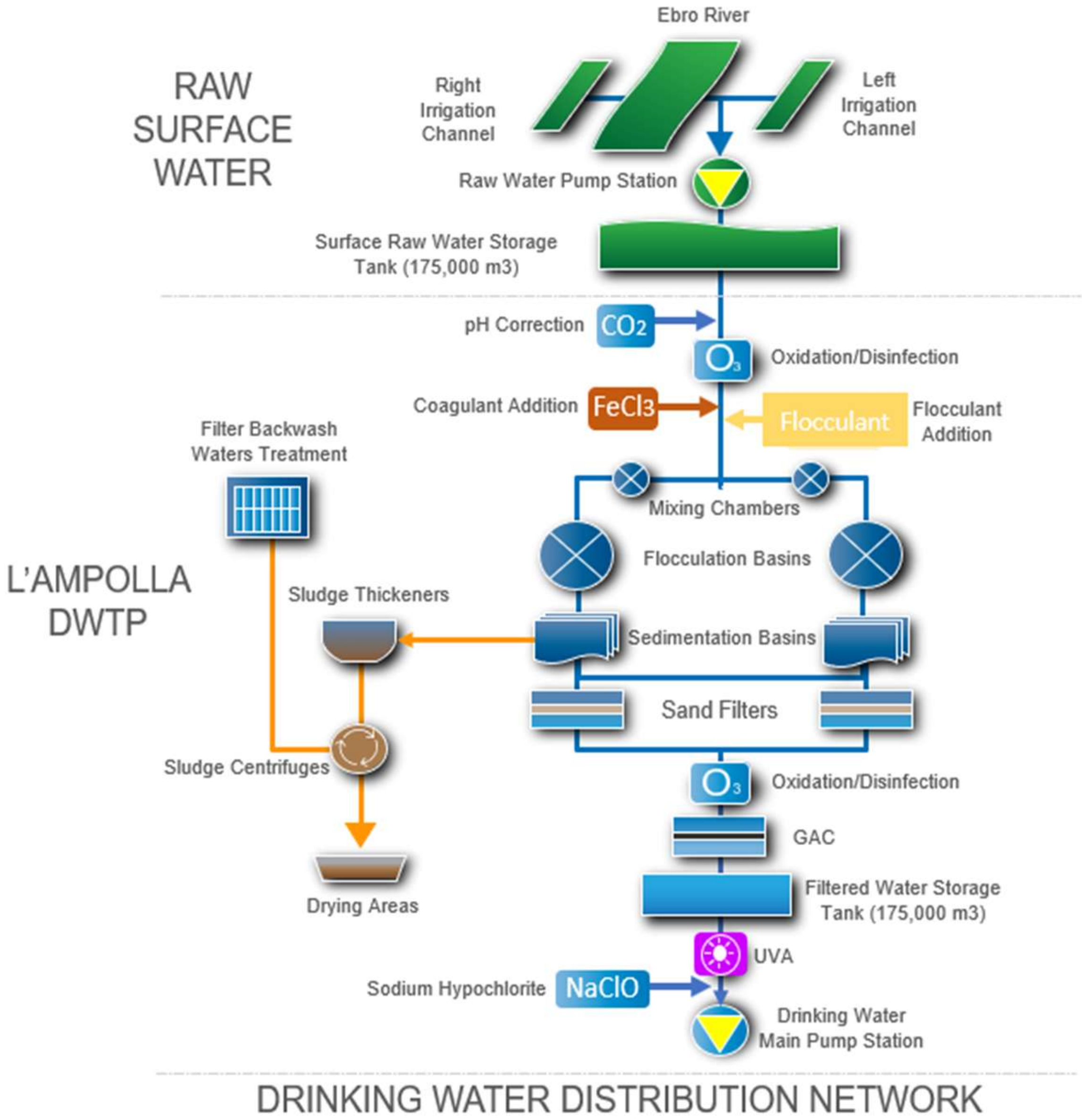
CS#3 Ampolla WTP



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WTP Process upgrades

Before 2000 → 2003 → 2008 → 2011 → 2018 → 2019 → 2022

Chlorine Gas

KMnO4 + Chlorine Dioxide

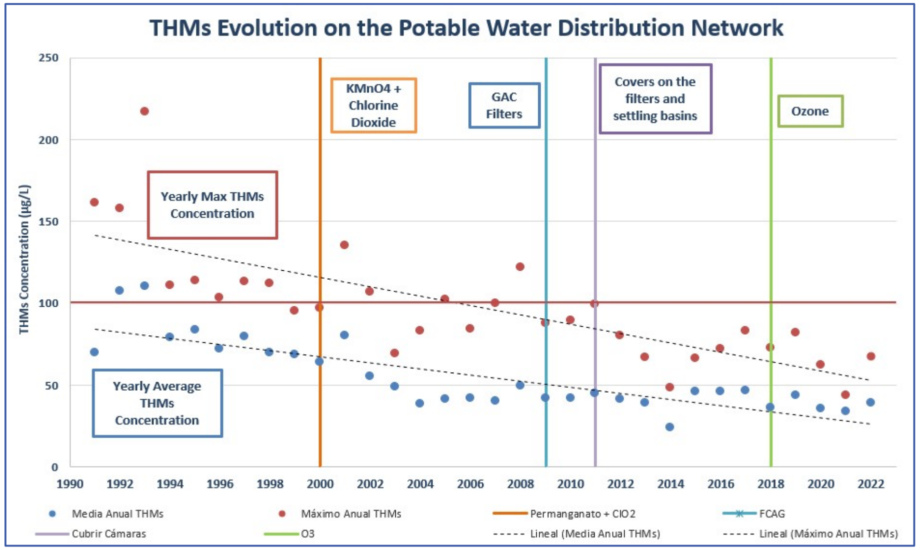
GAC Filters

Basins + Filters Covers

Ozone + Sodium Hypochlorite

Distribution Network electro-chlorination

UV disinfection



The ozone application, on April of 2018, reduced the DBPs precursors, measured as TOC and UV254.

The THMs concentrations in the drinking water dropped substantially thanks to the DWTP upgrades,

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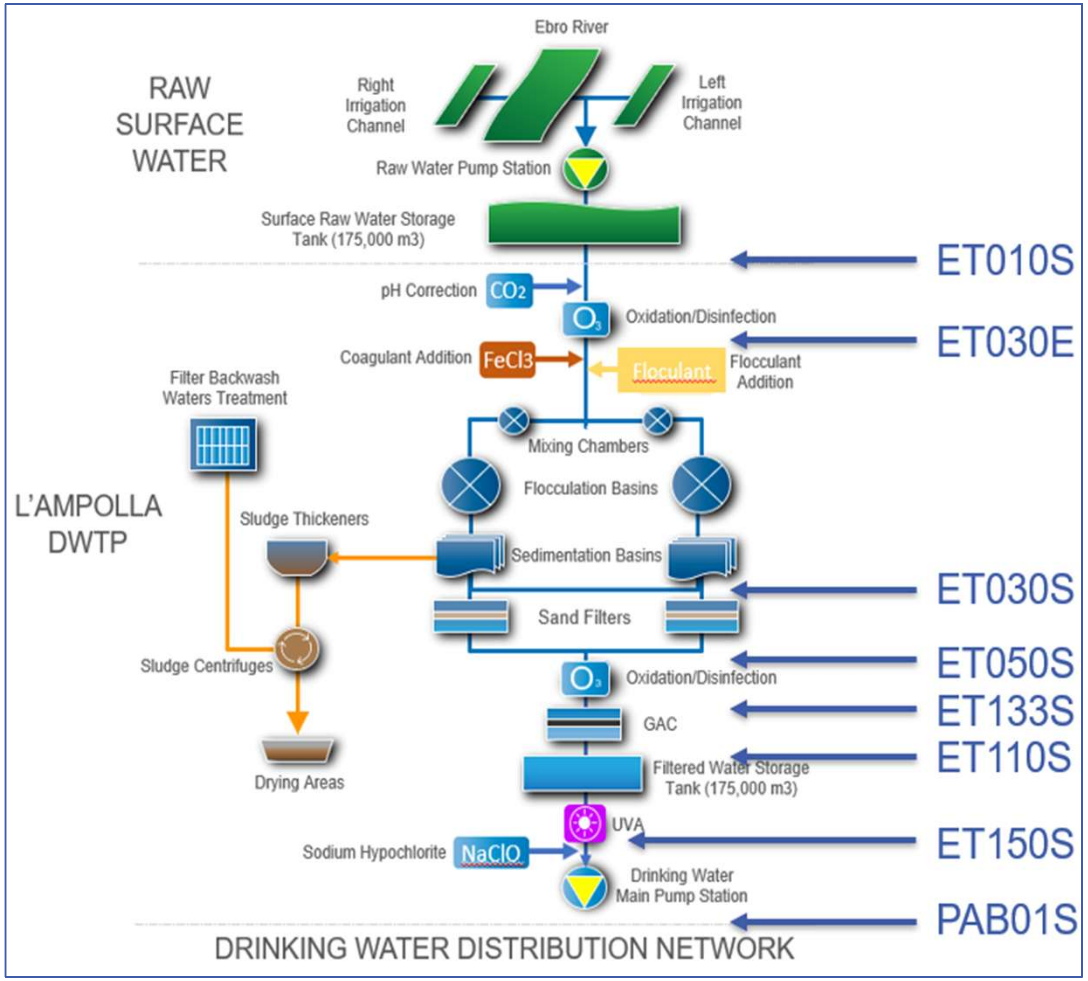
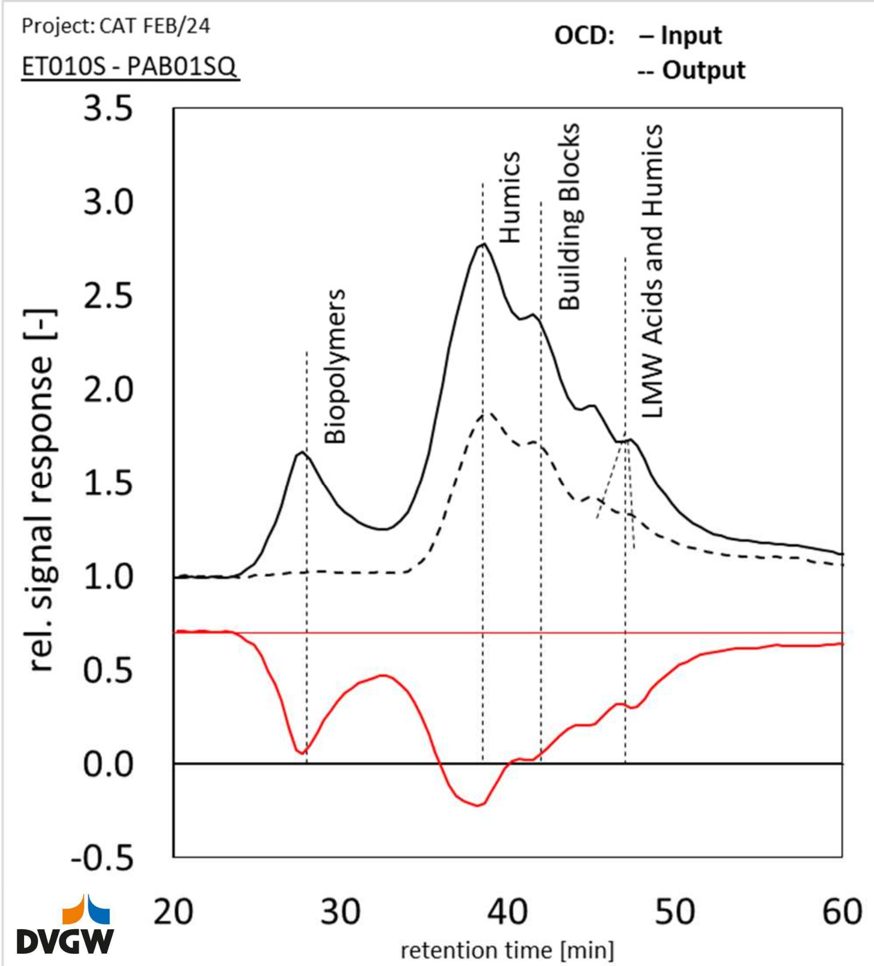
CS#3 NOM Characterization and elimination





Liquid chromatography-organic carbon detection (LC-OCD)

CAT treatment eliminates part of the NOM

Different efficiency with NOM fractions

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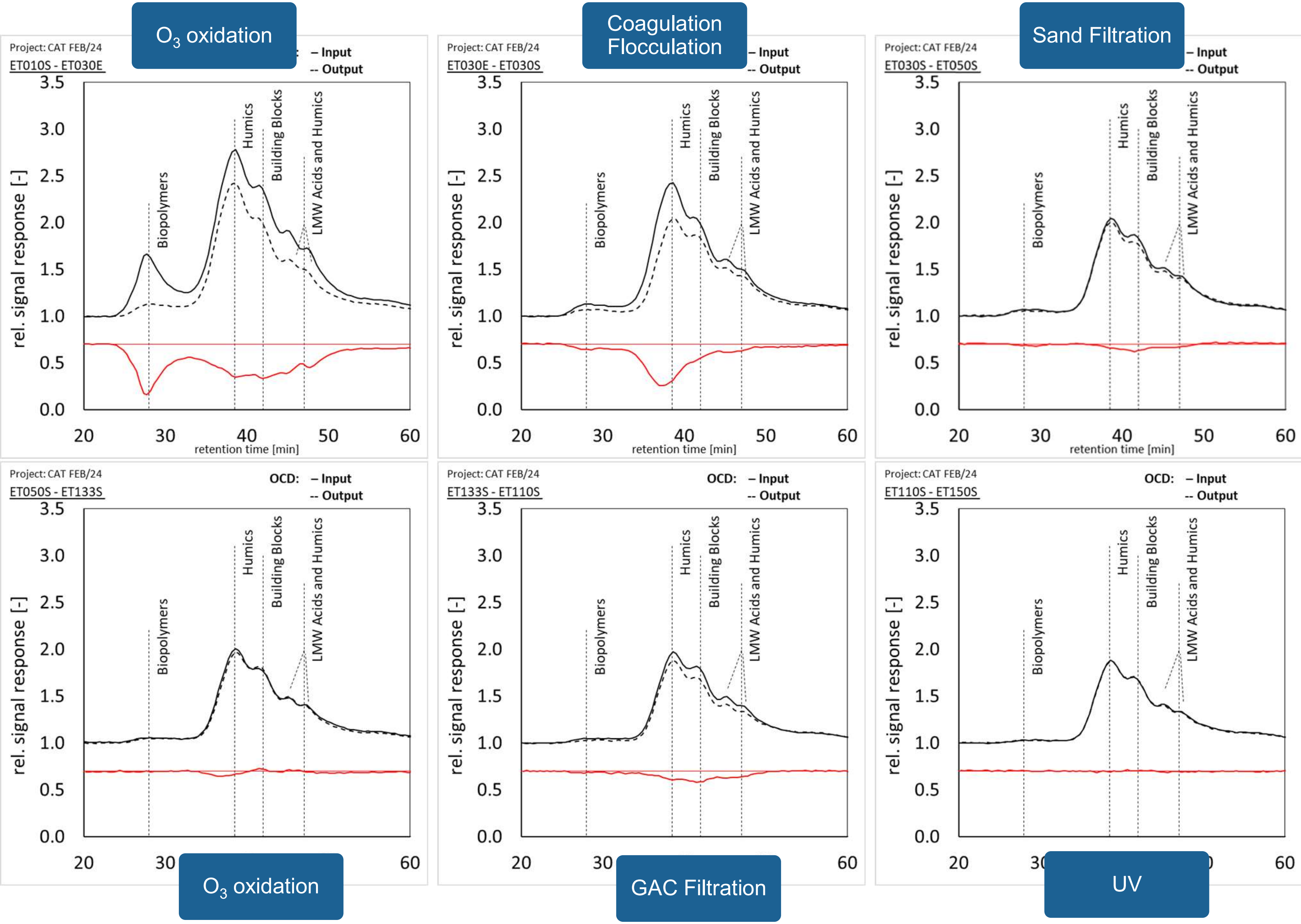
CS#3 NOM elimination in WTP steps



Initial oxidation and coagulation-flocculation are the main contributors to NOM elimination

Sand and GAC filtration can fine tune the final output

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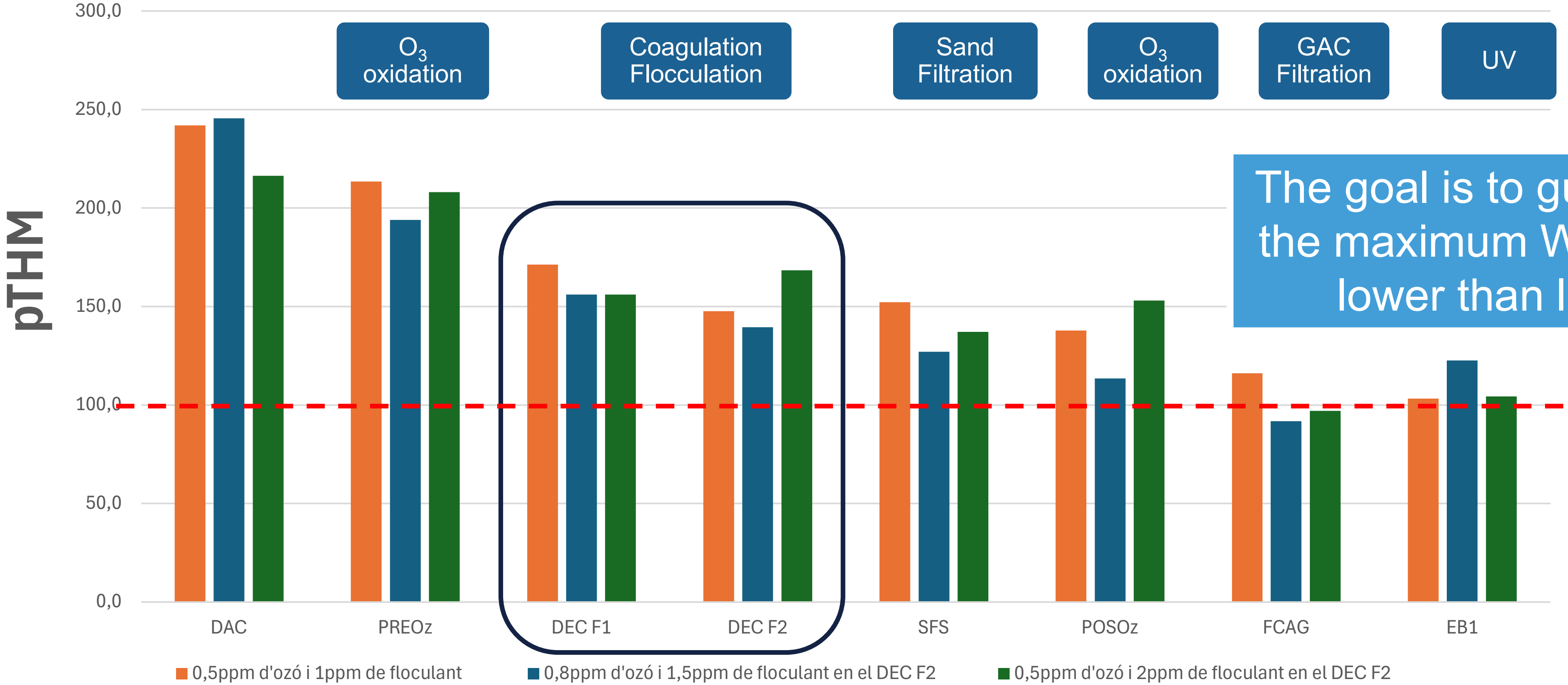
CS#3 DBP potential reduction

THM potential reduction through Ampolla DWTP



The goal is to guarantee that the maximum WTP output is lower than legal limit

Changes in the process have real effect on DBP output

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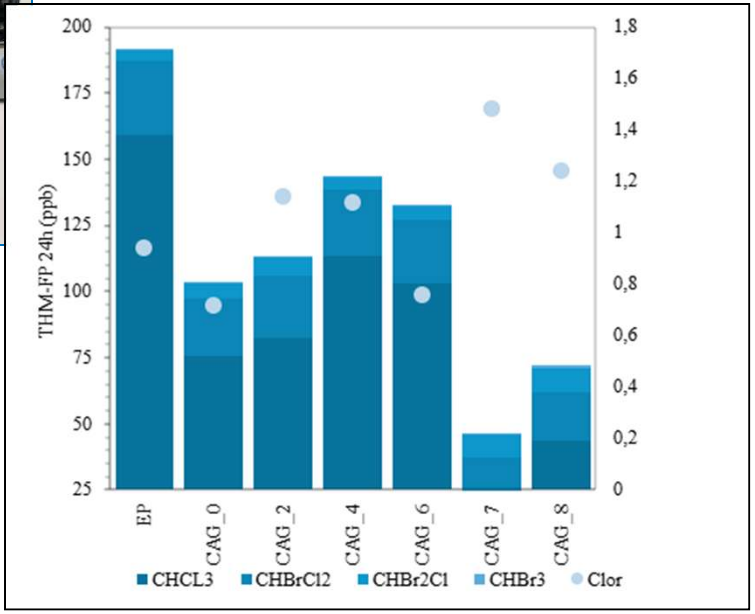
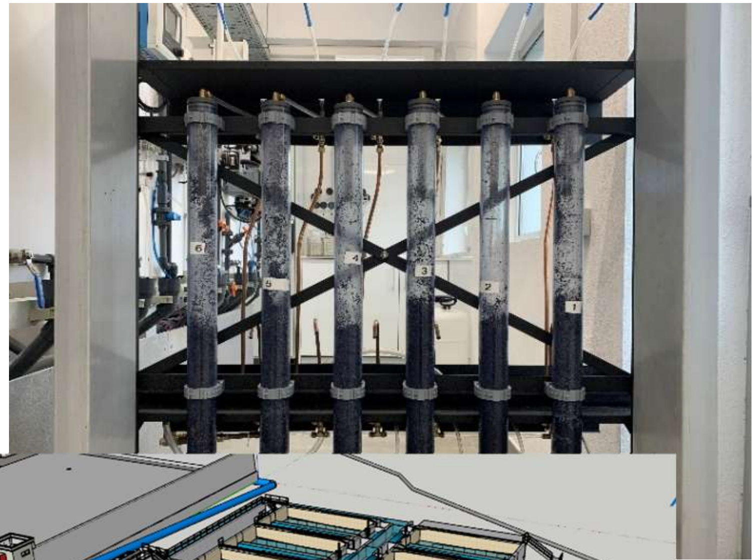
CS#3 Adsorption process changes

NOM/DBP potential reduction results in batch tests

Activated carbon selection can lead to different DBP generation



NOM/DBP potential reduction results in lab tests



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New cellulose-based adsorbents under study to improve NOM reduction

Comparison with real values

GAC durability is a key factor in DBP reduction

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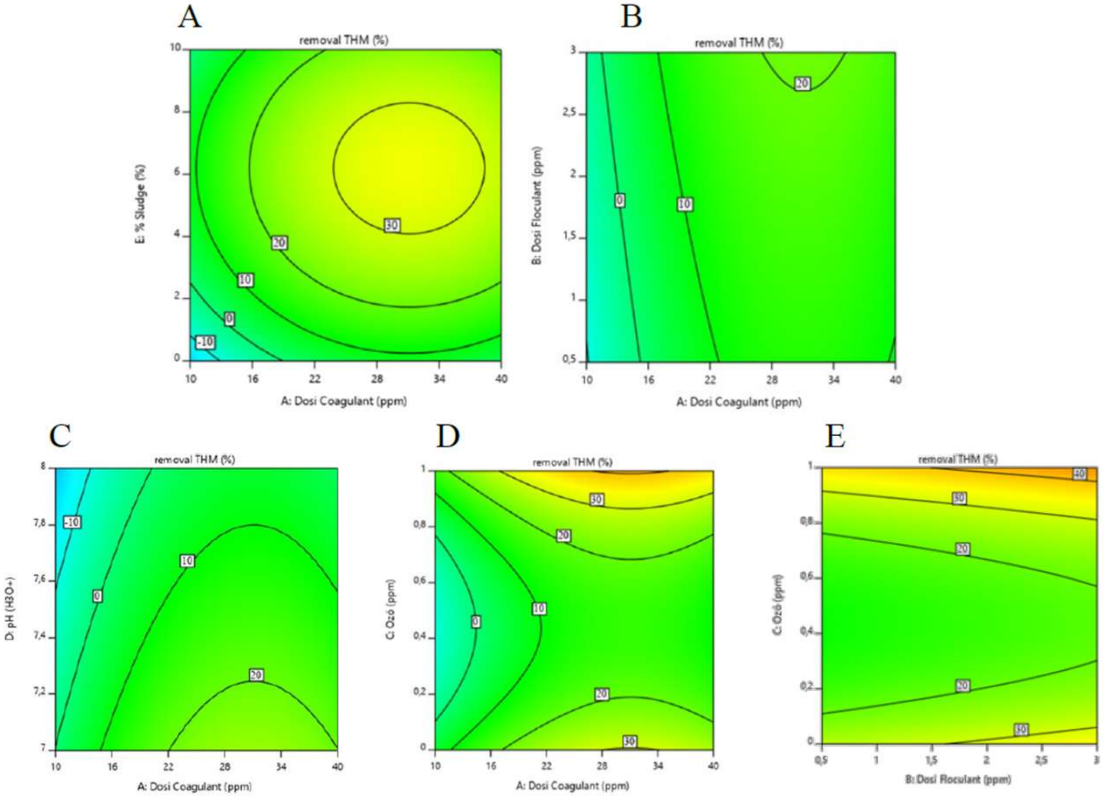
CS#3 Coagulation-flocculation process

NOM/DBP potential reduction results in jar-tests



Process model generation allows to optimize the desired DBP reduction

Table 1. Summary table of the factors that were considered in the development of the models for each response variable and their respective p-values.

Response variable	Operation variable	Factor	p-value
% Removal Turbidity	Coagulant (A)	CD	0.057
	Flocculant (B)	CE	0.061
% Removal TOC	Ozone (C)	DG	0.078
% Removal UV-254	pH (D)	E^2	0.037
% Removal THM-PF	% sludge (E)	AD	1.2×10^{-3}
	Turbidity input(F)		
	UV254 input (G)		
	TOC input (H)		
	THM-FP input (J)		

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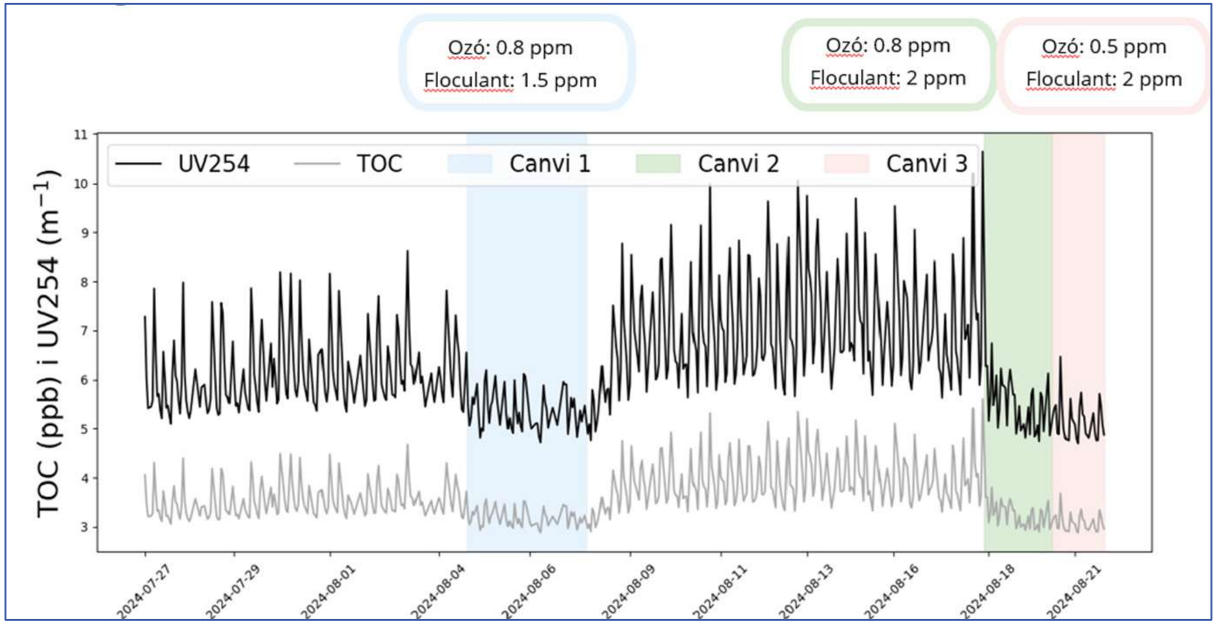
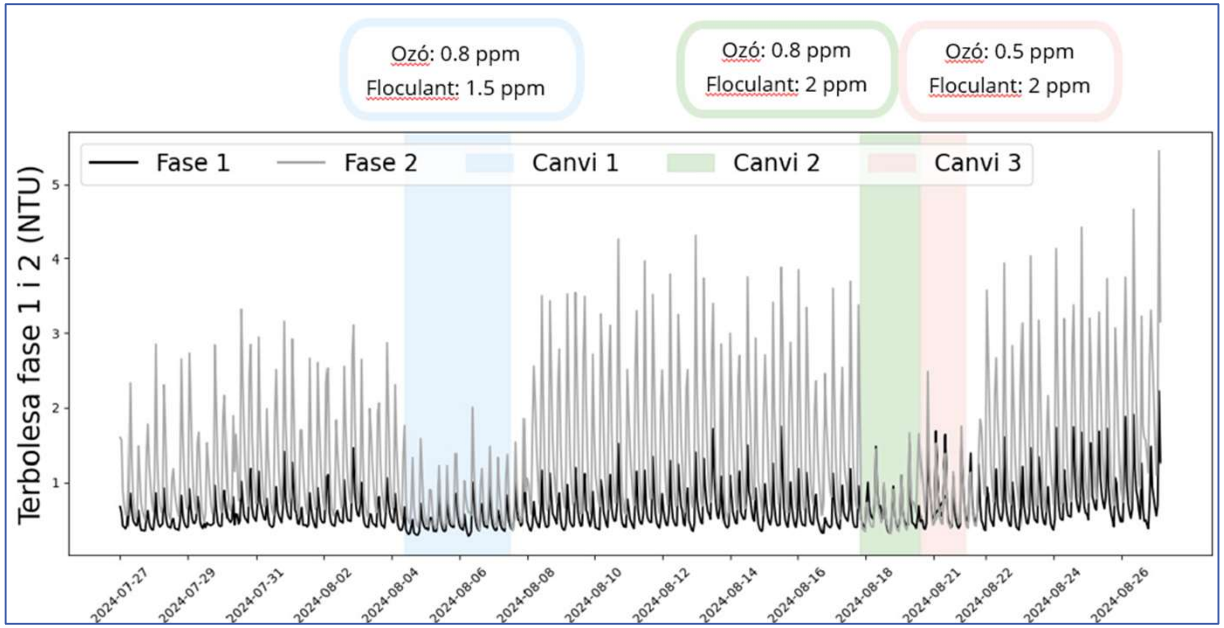
CS#3 Real WTP improvements

Lab tests were validated in WTP process

Clear improvement on TOC, UV254 and Turbidity align with lab tests





Initial results are promising. Further testing under way to verify results with different raw water qualities/seasonal effects

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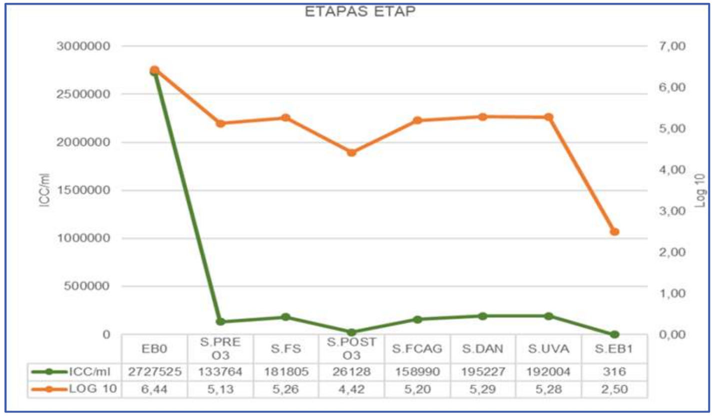
CS#3 Bacterial risk

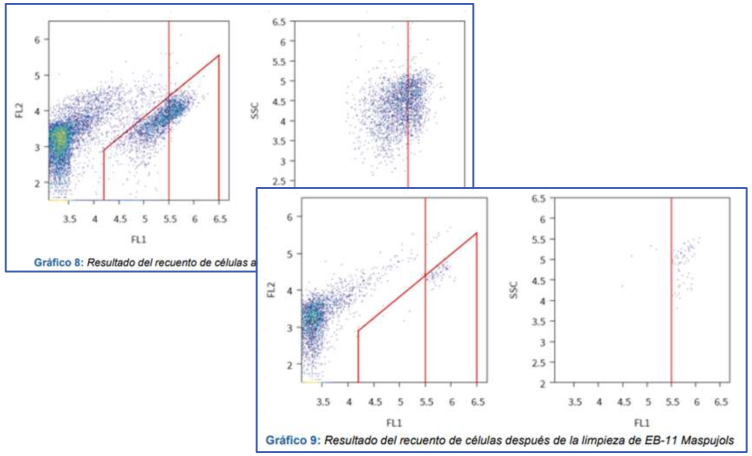
Flow Cytometer (FCM) for online reading of the total cell number

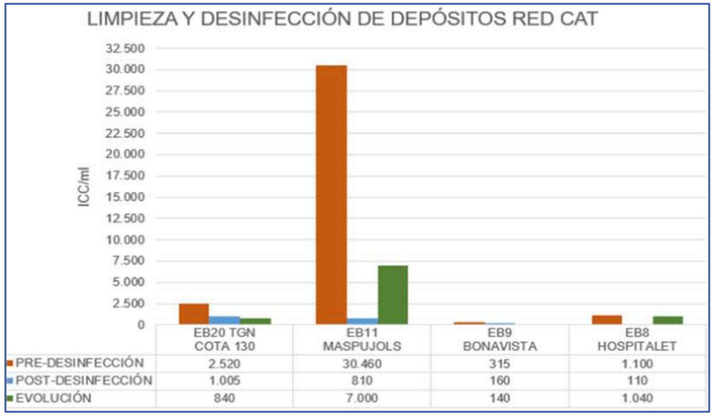
Cells reduction in DWTP processes



	EB0	S.PRE O3	S.FS	S.POST O3	S.FCAG	S.DAN	S.UVA	S.EB1
ICC/ml	2727525	133764	181805	26128	158990	195227	192004	316
LOG 10	6,44	5,13	5,26	4,42	5,20	5,29	5,28	2,50

Efficiency DW tanks cleaning





	EB20 TGN COTA 130	EB11 MASPUJOLS	EB9 BONAVISTA	EB8 HOSPITALET
PRE-DESINFECCIÓN	2.520	30.460	315	1.100
POST-DESINFECCIÓN	1.005	810	160	110
EVOLUCIÓN	840	7.000	140	1.040

FCM allows online measurements on bacteria growth

Free chlorine is required by Spanish legislation

The goal is to dose chlorine only when needed

PREALARM

≥ 3x10^4 ICC/ml  **Possible Bacterial risk**

ALARM

≥ 3x10^5 ICC/ml 

Bacterial risk

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CS#3 DBP models - prediction

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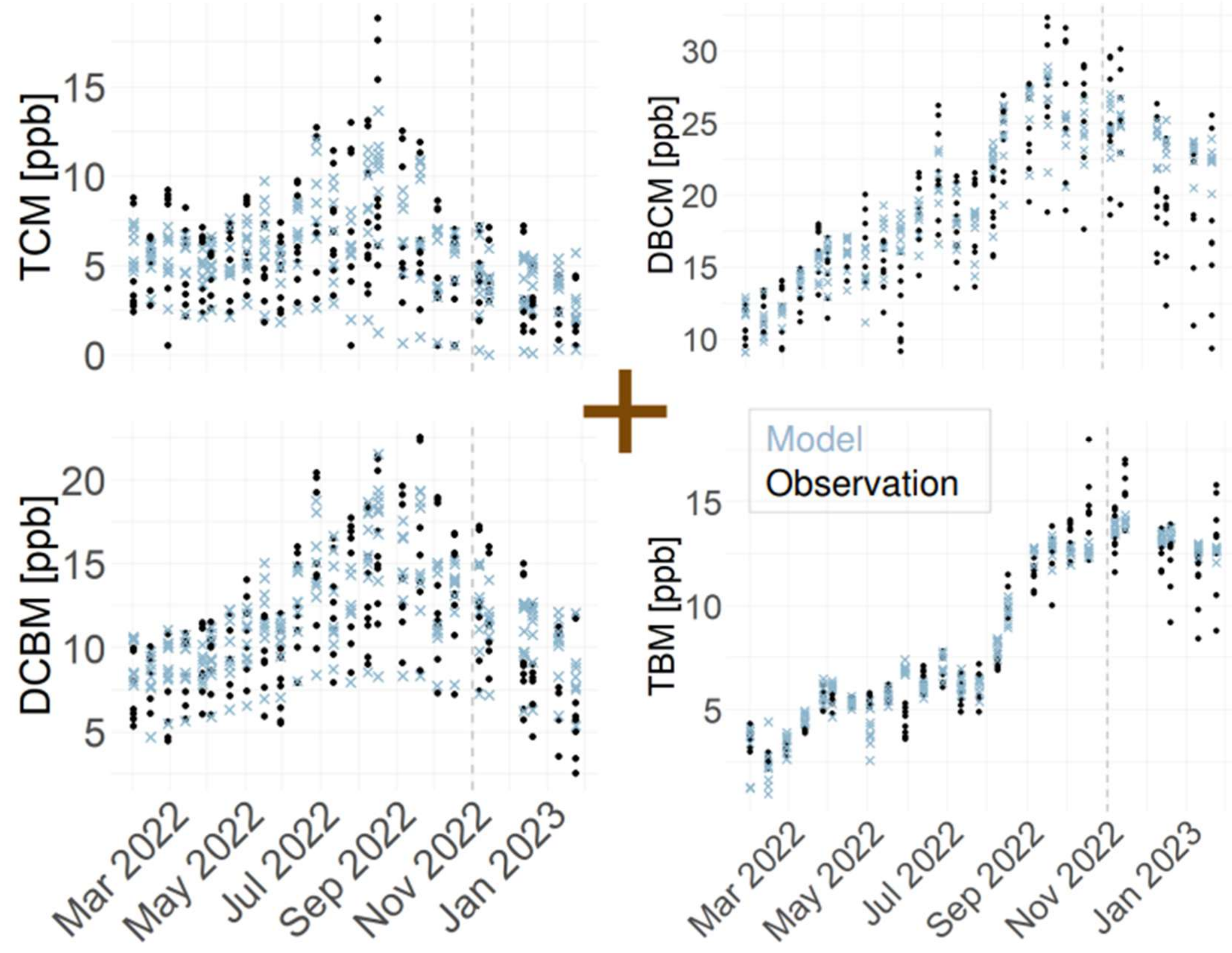
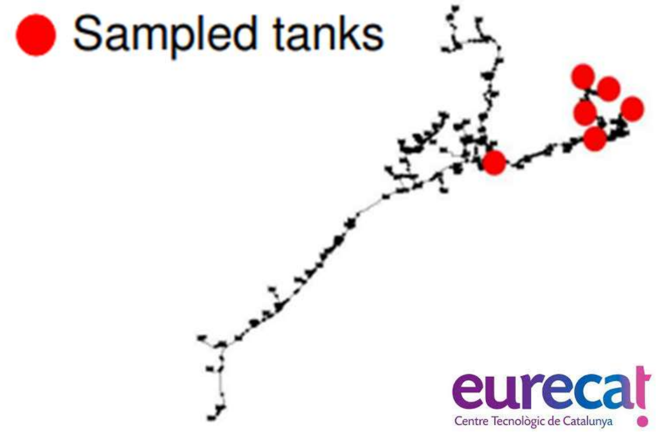
Large sampling tests have allowed to develop distribution network DBP generation models





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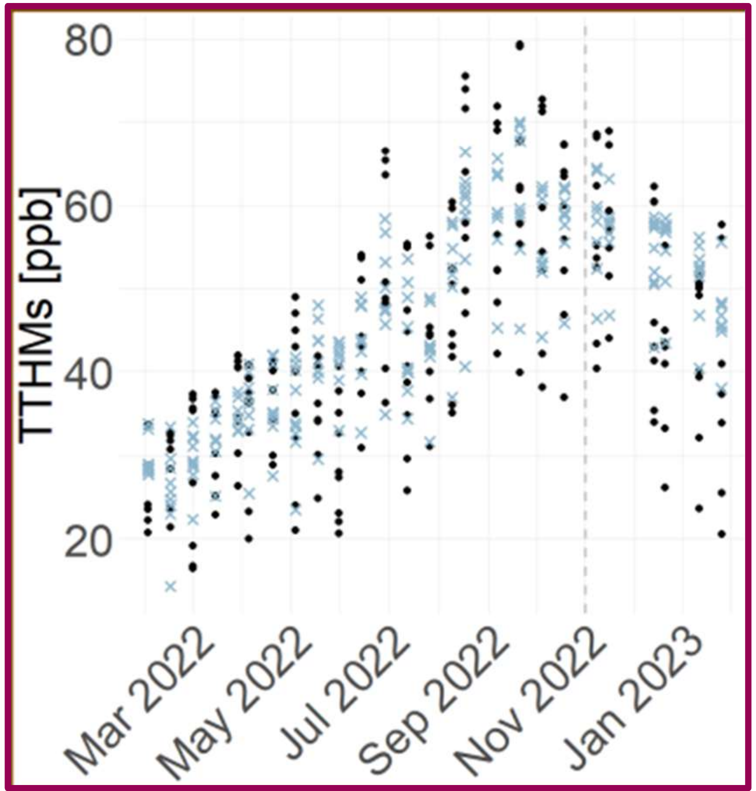

*Manuscript under preparation

CS#3 Chlorine dosage optimization

safe CREW

On-line DBP and bacteria sensors coupled with models allow chlorine dosage optimization

Reductions in chlorine dosage have a direct impact on reducing DBP health risks and generation of new types of DBPs (sDBPs and HANs)

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Take aways

Climate change impact on source water quality is already being detected and will worsen

Better knowledge of NOM and DBP precursors leads to treatment improvements

Treatment improvements have real impact on DBP formation

DBP formation models in the network are key to chlorination optimization and safer delivered water

The SafeCREW project is providing valuable information on how to adapt our processes to future water quality conditions

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Thank you for your attention!

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National University of Water and Environmental Engineering

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Umwelt Bundesamt

KWB Kompetenzzentrum Wasser Berlin

BDS BioDetection Systems

Consorci d'Aigües de Tarragona

UFZ HELMHOLTZ Zentrum für Umweltforschung

MM METROPOLITANA MILANESE SPA

TUTECH

multisensor systems

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